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INSTALLATION FOR SEQUENTIALLY TRANSPORTING OBJECTS IN A TREATMENT LINE FACILITY, IN PARTICULAR FOR THE CAR INDUSTRY

The present invention relates to the conception and manufacture of installations for transporting objects sequentially along a treatling line facility comprising at least one station for treating said objects individually. In a general manner, it aims at improving the operating conditions of robotized industrial sites, particularly by allowing high production rates thanks to better performance of the transport installations in speed and flexibility, while allowing great robustness providing safety of operation together with reduced infrastructure investments and maintenance costs.

The concept of a treatment station must be understood herein in a broad manner. It may, for example, involve subjecting the transported objects to surface treatments, to paint operations, dipping them in chemical baths or in electrochemical treatment baths as is conventional in lines for painting car bodies, just as much as operations intended to heat or cool the transported objects, or assembling operations wherein various pieces are added onto them.

The invention relates more precisely to an installation in which said objects are transported while suspended by pendles from two symmetrical conveyors which travel through the installation under the control of synchronized driving means to pick up said objects in a loading station and transport them individually to an unloading station while passing by at least one station for the treatment of said objects. In a general manner, considering an industrial production line, comprising one or more treatment in series, it may be considered that the so-called loading station is situated at the entrance of the installation while the unloading station is situated at the exit of the installation.

Installations of this kind are common, in particular in car manufacturing plants. A particular feature of such systems is that the

objects transported, especially when dealing with car bodies, are both heavy and bulky units. Probably at least partly for this reason, the conveyors used in practice in this kind of installation are currently chain conveyors in which the pendles which carry the car bodies constituting the objects being treated are affixed with articulation to the links of a chain travelling in translation on itself through the installation, along a travel path that is strictly defined by guide rails whose essential role is to support the weight of all the mobile elements. Accordingly, the articulation pins of the successive links of the chain are terminated by rollers which run captive in the guide rails during its movement.

According to the requirements of each particular application, the pendles ensuring suspension of the objects, more especially the car bodies as a typical example of the applications of the invention, may be implemented in various ways. Thus there are in particular implementations in which each car body is suspended by two pendles, one placed at the front and the other placed at the rear of the object in the direction of transport, and each said pendle is formed as a single piece thanks to a transverse bar securing together two vertical arms attached respectively to the chains of the two conveyors and the implementations in which the arms of the pendles are no longer connected in a rigid assembly and each car body is suspended on the two conveyors by four independent pendle arms.

The second implementations have over the first the advantage of lending themselves better to the implementation of relatively simple and nevertheless robust construction installations and of facilitating an equipment layout within a relatively small space requirement. For example, it is convenient to avoid having to provide devices for the engagement and disengagement of the pendle arms at the loading and unloading stations situated at the ends of the treatment line facility, by leaving these arms permanently mounted on the conveyors throughout the whole travel of the chains while they follow a closed loop path and are returned, on the side of the treatment line, from the station for unloading the car bodies already treated to the station for loading the car bodies to be treated. Most

frequently, each car body rests on a support usually called a sled, because it essentially consists of two parallel longitudinal beams, or so-called skids, which are used to support the car bodies through other production units, equipped with ground conveyors, and to transfer them from one conveyor to another, whether they be conveyors on the ground or conveyors in the air like those considered here.

Besides, the installations with air conveyors of the type considered in the context of the present invention are particularly appreciated for providing the transport of the car bodies along circuits involving inclined sections, when in particular the car bodies have to be dipped in treatment baths in tanks as is encountered in cataphoresis paint lines. Now the implementation of the invention has shown itself to be particularly advantageous in this type of situation, due to the fact that the moving loads tend not to be balanced and exert excessive forces on the driving chains.

For the purpose of providing a better response than in the past to the needs of industrial practice, the invention makes provision for dispensing with the driving chains of the current known implementations and the problems that they raise, by providing the drive of the pendles for suspending the objects to be transported on cables which, in each conveyor, combine the role of traction motive means with that of carrying means for the loads transported, while being kept tensioned on guide wheels in order to define a predetermined conveying circuit.

More particularly, the subject of the invention is therefore an installation for sequentially transporting objects in a factory line facility, in which said objects are transported while suspended by pendles from two symmetrical conveyors which travel through the installation under the control of synchronized driving means to pick up said objects in a loading station and transport them individually to an unloading station while passing by at least one station for the treatment of said objects, characterized in that, in each of said conveyors, said pendles are attached in fixed positions distributed

along a cable which is moved by said driving means while being kept tensioned on guide wheels defining a predetermined transport circuit, and in that the loads thus suspended on said cable via the pendles are carried exclusively by said cable between said guide wheels.

It is understood that thereby, said cable forms both traction motive and carrier means for said objects, and that on the sections of the travel path situated between guide wheels, it is free to contribute to providing, and even provide on its own, for the balancing of the pendles and loads with respect to vertical equilibrium, due to an effect of torsional elasticity of the cable. It should be considered that here and in the rest of the description of the invention, when mention is made of guide wheels in general, this may involve as well either individual wheels some distance from one another or sets of wheels playing an equivalent role in providing a friction-free guidance contact with the cable. In the case where the wheels or the groups of wheels are evenly distributed at equal intervals along the path of the cable, it is advantageous to provide that the separation between two successive guide sets covers a distance different from the distribution pitch of the pendles, or more generally from the gap between two pendles supporting one same load. Thus, when a pendle for suspending a determined load on a determined cable passes over a guide wheel, the other pendle associated with the same load and with the same cable is necessarily in a zone of the circuit in which the cable is free of all guidance.

This balancing capability, which partly or wholly replaces the mounting with free articulation in the transverse direction encountered in previously known installations, is particularly appreciable in the installations in which the path followed by the objects to be treated comprises inclined portions, which is notably the case for motor vehicle production plants, in the lines for painting the car bodies by phosphorization or in lines in which a surface treatment is applied to them by cataphoresis, since the car bodies must be dipped in a tank containing a treatment bath and then passed over into a drying booth.

In such installations involving an inclined path, the invention provides various advantages which are reflected in additional features of the invention. In particular, the flexibility of the tractive carrier cable allows extremely tight curves, thereby allowing relatively short inclined paths for passing from one treatment level to another and an overall reduction of the length of the installation. It is then desirable for the tractive carrier cable to be free of all guidance in its running stretch on the sloping section passing from one level to the other, when it is sufficiently tensioned to have an incline remaining always in the same direction. Greater benefit is thus derived from the elasticity effects in lateral balance of the loads on their passage into the tank, which effects are linked to the flexibility of the cables.

The tractive carrier cables used according to the present invention also have the value of facilitating the implementation of installations of reduced bulk in the transverse direction, because the same flexibility of the cables makes it possible to mount the arms of the pendles in cantilever manner, so that they reach an attachment point to a car body receiving sled situated beneath the car body, while passing out around the latter. The implementations of this type are called as having narrow sleds, as distinct from the case of sleds having protrusions for being grasped by pendle arms which pass outside the bulk of the conveyed object, in order that the arms hang vertically.

In addition, it is easy to understand that the reduction in bulk resulting from the invention go hand in hand with a reduction in construction costs and maintenance expenses and with reduced requirements in ventilation, heating, etc.

Furthermore, dispensing with the driving chains of the conventional installations and the continuous carrier rails has as a corollary a considerable reduction in the lubrication requirements and a notable improvement in the stability of operation over time, hence better security for reduced maintenance expenses. In practice, the problems that resulted from the phenomena of lengthening of the conveyor lines through wear of the articulations between chain links

no longer exist, and it is no longer necessary to periodically compensate for a differential lengthening between the two lines. In addition, there again, the natural flexibility of the cables limits the harmful consequences of such a differential lengthening. In total, this facilitates the synchronization of the driving means driving the cables along on themselves, as is necessary, above all for keeping the attachment points of the two arms of one and the same pendle on the same member set transversal to the conveyor lines, and incidentally for keeping a uniform driving speed.

According to other characteristics of the invention, the implementation of the installation involves an adjustment step prior to its normal operation, consisting essentially in tensioning the cables, by pulling each one at one of the ends of the installation, to bring them to their maximum length before attaching thereto the various pendle arms, in positions of mutual correspondence (between the two conveyor lines) for the suspension of the objects to be transported.

As a consequence, the installation according to the invention advantageously comprises appropriate tensioning means for each of the cables that it comprises. Such means of tensioning a cable are conventional in themselves.

According to preferred embodiments of the installation according to the invention, each of the moving cables describes a closed loop comprising one conveyor circuit portion called active, or forward stretch, going from the station for loading the objects to the unloading station, passing via the treatment station or stations, and one inactive circuit portion, or backward stretch, returning the pendle arms only, empty, from the unloading station to the loading station, there to load a new object to be processed. The means of tensioning each cable may then advantageously comprise a cable return wheel mounted mobile under the action of a cylinder in order to move it away from the rest of the installation and thus lengthen the loop traveled by the cable. Where appropriate, this return wheel may also play the role of a driving wheel gripping the cable to provide its closed loop drive. According to the needs of each particular

application, each such cylinder may be mounted permanently in order to continue to exert its tensioning effect when the installation is in operation, or be removed once the cable has been lengthened, after having locked the return wheel, by which the traction was exerted, in a fixed position.

In its preferred embodiments, as they may be particularly suitable notably to the needs of the car industry, the invention makes provision for forming the carrier tractive means of the objects, on each of the conveyor lines, by two coupled cables, between which are situated the points for attaching the pendle arms. The coupling between the two cables of each conveyor is advantageously provided, at each pendle arm, by a grip for attaching the latter which clamps onto both of the cables. The solution with two coupled cables has the advantage of distributing the forces exerted on the cables, of allowing smaller cross-sections of cables promoting their flexibility exploitable according to the invention, of avoiding a lateral swinging of the arms which would disrupt the smooth operation of the installation.

Preferably, whether the tractive carrier means be with a single cable or with two coupled cables, the arms are mounted free to pivot in rotation about a transverse shaft, more particularly a pin perpendicular to the conveyor line, therefore from front to rear in the direction of conveying. This freedom of orientation in the longitudinal vertical plane is useful for several reasons. First of all, it is usually necessary, at least in a small angular gap about the vertical, for the operations of picking up and releasing the loads, particularly of the sleds on which the car bodies normally rest, which require the locking or unlocking respectively of the bottom ends of the pendle arms on transverse members of the sleds fitted with interacting handles. Also, it is desirable, even necessary over a greater amplitude, to allow the pendles to balance themselves vertically in the sections of the conveyor circuit that are on a slope in the case treatment lines with inclined portions.

Finally it has the advantage of making it possible, in preferred embodiments of the installation according to the invention,

to fold back the pendle arms in a position inclined toward the cable or the cables to which they are attached when they circulate empty, in particular when they return from the unloading station to the loading station on the path of a closed loop conveyor. This capability is useful particularly in all cases where it appears desirable to install the various elements of the installation in a minimal space, in particular in an enclosed space as is usually the case in industrial sites, all the more so when there may be chemical vapors therein.

According to another feature of the invention in connection with the organization of the circulation of the pendle arms, the cables of the conveyors describe closed loops remaining in one and the same vertical plane, preferably with a return backward path of the arms placed above the stations for treating the transported objects, in particular when it involves stations for treatment in tanks requiring inclines. Specifically, it is desirable that along their complete path, the cables work in curved zones in the same plane as when they pass over the driving wheels or the return wheels or guide wheels on which they are tensioned.

Other features of the present invention relate to the method of driving the conveyors, mainly in their synchronization, which is advantageously provided at least in speed of travel of the cables, where appropriate also in position on their respective paths when it is necessary to compensate for a slippage such as that which can sometimes occur through slippage of a cable on the driving wheel driving it. The pendle arms may advantageously form the position markers used for this adjustment.

Further features and advantages of the invention will appear on reading the following description of preferred embodiments of the various essential portions of an installation according to the invention, considered as it applies to the transport of car bodies in an industrial treatment line facility. This description is made with reference to the drawings that it comprises, wherein :

- Figure 1 shows in schematic manner, in top view, the general structure of a first embodiment of the installation according to the invention ;

- Figure 2 represents schematically, in side view, a similar installation in which the car bodies are undergoing a treatment in a tank in a cataphoresis bath ;

- Figure 3 illustrates schematically, for an installation according to figure 1 in side view, a car body being transported as suspended by the sled that carries it on single-cable conveyor cables ;

- Figure 4 shows in schematic manner the installation at the same car body, seen from behind in the direction A of figure 3, and it shows the section line BB used for figure 3 ;

- Figure 5 is the counterpart of figure 4 for an installation with two dual-cable conveyors, also in which each cable travels on a closed loop situated in one same vertical plane ;

- Figure 6 is a schematic side view of the same installation along the section line CC of figure 5, which emphasizes the position of the pendle arms on passing the loading end ;

- Figure 7 represents in greater detail a form of construction of a cable tensioning system, taken to be situated at the end of the installation corresponding to the unloading station ;

- Figures 8 and 9 are respectively side views and front views of a pendle arm showing it in its mechanical relations with the tractive carrier cable of a single-cable conveyor such as that in figures 3 and 4, while applying more particularly to the case of an installation with narrow sleds ;

- Figures 10 and 11 are counterparts of the preceding figures for a dual-cable conveyor better suited to the features of the invention in its preferred embodiments, while on the other hand applying to the case of an installation with wide sleds.

In the various embodiments of the invention herein described, consideration is given to an installation intended for the car industry, involving more precisely a materials handling line in which the objects individually conveyed suspended on two parallel conveyors are car body shells 5 each resting on a support such as a so-called sled 3, onto which are attached four independent suspension arms 4 (figure 3), also numbered 4R on the right and 4L on the left (figure 1) when looking in the direction of movement illustrated by the arrow A in the figures. This solution is generally more advantageous, particularly for an optimal exploitation of the flexibility of the cables used as tractive also load carrier means, than that which consists in suspending the car bodies, with or without supporting sled, by two rigid pendles, each linking two fixedly attached arms relating respectively to two parallel conveyors, one of the pairs of arms forming the pendles being situated at the front and the other at the rear of each car body conveyed.

According to a first embodiment of the installation according to the invention, illustrated by figures 1, 3 and 4, the two conveyors 6 in the installation, numbered respectively 6R and 6L, have each a single tractive carrier cable 60 (or 60L and 60R respectively) and, on another hand, each cable is driven in translation on itself to travel a path along a loop which is closed in a horizontal plane at each end of the installation. In their forward stretches, on the portion of their circuits in which they are active in transporting the loads, the two cables are laterally spaced apart in the mid-portion of the installation. On the return path, the pendle arms remain secured to the cables in their respective positions and circulate empty along passive backward portions of the circuit that are situated on either side of the mid-portion of the installation, as was the case for the chain conveyors of the installation described in European patent EP 1 104 737. Note that this disposition requires a suspension by front and rear pendles that are each made of two independent pendle arms.

Thus, considering figure 1, there is a load 3-5 (body 5 resting on the sled 3) in an intermediate position along the installation, between a loading station 7 at the entrance of the

installation and an unloading station 8 at its exit. At these two ends of the installation, each of the successive loads is, respectively, either picked up by four pendle arms of the installation from a conveyor on the ground having brought it to a lift-lower system 71 (figure 2), or deposited on a symmetrical lift-lower system 81 by which it passes to another conveyor on the ground once its treatment in the installation of the invention is terminated.

In the lower portion, at its distal end relative to the cable to which it is attached, each pendle arm 4 (or 4R, 4L) is formed (in a manner conventional in itself, and described for example in the European patent already cited, so as to form a pick-up hook for an interacting handle 30 provided on a sled 3 (figure 3). Under a spacing equal to the pitch separating two successive arms of each conveyor, each sled 3 comprises two handles 30 either side, respectively on the two longitudinal skids of the sled, at the ends of crossmembers connecting the two skids in a rigid assembly. The hooks 42 (figure 3) engage with the handles 30 of a sled 3 which is raised to the loading station 7 by an elevator table 71, and they are released from it onto the system 81 of the unloading station. The pendle arms 4, once thus unhooked from the sled 3, return empty to the entrance of the installation, to pick up a new sled with its car body.

In the top portion, at its proximal end, each pendle arm 4 is assembled to the cable 60 by a pivot system 43 and grip 45 (figure 9) which holds it in a position remaining permanently attached to the moving cable while allowing it full freedom to pivot in the vertical plane of the conveyor. Since the conveyor illustrated in figure 9 has a single cable (single-cable version of an installation according to the invention), provision has been made in this case for a cantilever suspension of the sleds, the arms 4 being formed bent and curved around the car body conveyed outside it so as to extend and reach a so-called narrow sled. However, unlike what is shown by the figures when in the situation of an installation of minimal height requirement, thanks to a horizontal disposition of the conveyor circuits, it is usually more advantageous to construct the fixed framework supporting the various elements of the installation such that the attachment points of

the arms at the top to the cable and at the bottom to the sled are placed in one same vertical plane.

The cables 60 are made up, in a manner conventional per se, of a plurality of bundles wound in a helical spin about a central core, each bundle advantageously being itself formed of several bundles of metal wires spun together. Before the installation is started up in normal operation for the transport of the loads, the cables need to be subjected to a progressive tensioning procedure during which they are lengthened. Once this procedure is terminated, they remain tensioned in a definitive closed loop circuit practically without lengthening further.

The conveyor circuit is closed in a loop while passing around a driving or motive wheel 61L or 61R which pulls the cable along its active portion transporting the loads from the exit end of the installation, at the unloading station 8, and around a return wheel 62L or 62R situated at the opposite end, at the loading station 7. The motive wheel 61L, 61R, of the pulley type, drives the corresponding cable 60 by non sliding contact in its sheave. It pulls on the cable to drive it around the conveyor circuit through the treatment station or stations that make up the installation. It is driven in rotation by a gear motor, ML or MR respectively. The return wheel 62L, 62R, also of the pulley type, is mounted in free rotation on the fixed framework.

Between the two ends of the loop, the path of each cable 60 is defined by guide wheels 63, distributed along the installation. Such guide wheels are found in particular where inclined paths must be imposed, as is the case for the treatments carried out in tanks as in figure 2. It may be observed, particularly in the side views of figures 2 and 3, that the distance between two successive guide wheels (or between two equivalent groups of guide wheels as illustrated by figure 2) is greater than the pitch of distribution of the pendle arms along the cables.

Figure 1 illustrates schematically the presence of gear motors ML and MR which drive respectively the driving wheels 61L

and 61R. They are supplied independently of one another with electric power with slaving as to speed and position. Specifically, a control circuit 9 delivers to the gear motors ML and MR, respectively, alternating current supply voltages AL and AR which are determined so as to provide a synchronous drive of the cables, with slaving of speed and position, between the two conveyors 6L and 6R. One of the conveyors is controlled by the circuit 9 as the master conveyor and the other conveyor is controlled as the slave conveyor, slaved as to speed and position to the master conveyor. The master conveyor is controlled so as to provide a cable travel speed complying with a set point value of speed V.

The slaving inverse feedback loops on the commands of the gear motors ML and MR are produced respectively with the aid of sensors SL and SR, consisting for example of optical sensors associated with the conveyors 6L and 6R respectively. These sensors SL and SR supply the circuit 9 with inverse feedback signals FBL and FBR, in correspondence with the detection of position markers passing in front of them. The position markers may consist of marks 66 (figure 1) made on the cables themselves and distributed at identical regular intervals along their length. According to a preferred variant, the function of the position markers of the cables is fulfilled by the pendle arms 4L and 4R, or better by the members that provide the link between each pendle arm and the cable to which it is attached (grip system 45).

The slave control supplied by the circuit 9 is determined so as to ensure that the pendles 4L and 4R are aligned between the two sides of the installation on the same transverse direction. It is used to make good a possible differential slippage of the cables on their driving wheels, so that a correct positional relationship is always maintained between the pendle arms and the sleds.

As already indicated, the guide wheels 63L and 63R are mounted rotatably by their respective axles in fixed positions of the installation, which is illustrated in figures 3 and 4 by a mount on top portions of vertical uprights, 64L and 64R. In an installation which, in

this case, is intended to be of the straight line type, the uprights 64L and 64R are aligned respectively along two longitudinal axes of the conveyors 6L and 6R, parallel to the direction of travel A, with a predetermined lateral spacing between them, corresponding to the width of the loads to be transported.

Considering the forward circuit portion going from the loading station to the unloading station, one can observe that the counterpart wheels of a pair 63L-63R are mounted on opposite faces facing the uprights 64L and 64R, on the inner side of the latter, and that their axles are situated in one same horizontal plane common to the two conveyors 6L and 6R. One will observe also that the same uprights are used symmetrically, each on the outer side, to support the guide wheels 65A or 65B, which are reserved for the guidance of the same cable, respectively left or right, on its stretch returning the empty arms backwards. An important variant of the assembly illustrated here would consist in inverting the position between guide wheels and pendle arms, by mounting the rotation axles of the wheels inside the posts transversely extending the supporting upright or an equivalent beam.

Figures 8 and 9 show more precisely, still for an installation with single-cable conveyors, the mechanical relationships existing between a guide wheel 63, the corresponding cable 60 (that of the left conveyor 6L in this instance) and a pendle arm 4, the latter being represented at the moment when it passes over the guide wheel 63. Naturally, these figures and their description would be symmetrically identical for the corresponding members of the installation considered not on the left conveyor but on that of the right side of the installation.

One can observe that the guide wheel 63 comprises a sheave groove to receive the cable 60 by preventing it from diverging laterally from its normal path. It is mounted to rotate freely on a horizontal axle, connected in fixed position to the corresponding upright 64L. The pendle arm 4 is, for its part, mounted to rotate freely on an articulation shaft taking the form of a rod 47 swiveling in a pivot

race 43 and extended by a grip 45 which is firmly clamped onto the cable, such that the articulation shaft of the arm is thus fixedly attached to the cable. The articulation shaft is oriented perpendicular to the cable and in the horizontal plane defined by the parallel cables of the two conveyors. In other words, the arm is assembled to the cable so as to constantly allow its front-to-rear (and vice versa) oscillation, in the normally vertical plane of its movement as defined by the conveyor circuit.

Relative to the conventional installations, which did not use traction cables having a carrying effect on the loads transported, the installation according to the invention involves pendle arms 4 of simpler design, due mainly to the reduced number of degrees of freedom in the assembly between each pendle arm and the corresponding tractive carrier cable. According to the invention, the preference is for the articulation described hereinabove, since it is preferred to make use of the elasticity of the cables, and particularly of their torsional elasticity.

Another preferred embodiment of the installation for transporting objects according to the invention is chosen for the treatment line illustrated by figure 2, comprising a step in which the car bodies 5 on their sleds 3 must be dipped in an electrolyte bath contained in a tank 2. In this case, it is specifically more advantageous to organize the conveyor circuits so that the path of each cable is entirely included in a vertical plane. In this way, all the curved sections of the cable path around the guide wheels (including therein the driving wheels and the return wheels) are situated in this plane, which is favorable to the service life of the cable.

Figures 5 and 6 also have the value of illustrating this solution of conveyors in a vertical plane whether the circuit in its forward stretch comprises inclined portions or not. Such a design satisfies a minimal width space requirement. Furthermore, the installation is here shown in a version equipped with wide sleds, onto which the suspension arms are attached at vertical level with the cables either side.

Another enhancement, at least as important, provided according to the invention in this second preferred embodiment, resides in the fact that each conveyor is of the so-called dual-cable type. In each conveyor, the two cables are driven in synchronism along the conveyor circuit, to follow strictly parallel paths, and each pendle arm is mounted hanging between the two, in a fixed position on the two cables. The two cables are thus coupled via assembly devices attaching the articulation shaft (or pin) of the pendle arms onto the cables.

In the installation with two conveyors, each being dual-cable considered here, provision can be made for the four cables to be driven in synchronism and perfectly positioned relative to one another, so as to reduce the forces that may exert on the assembly devices between the cables and pendle arms. Use is then made of the same control system with slaving at least in speed, and preferably also in position, as that which has been described previously for the installation with two single-cable conveyors, except that the control circuit is suitable for controlling the respective motors. As aforementioned also, the pendle arms, at their attachment to the cables, are advantageously used to form position markers repeated regularly throughout the length of each circuit. As a variant, the synchronization is provided in speed of cable travel for the four cables, and any making good of longitudinal position is provided between the two conveyors only, while trusting, for the two cables of one same conveyor, in the fact that they are coupled via the articulation pins of the pendle arms.

Figure 5, in particular, illustrates the form the tensioned cable circuits may take for the two symmetrical air conveyors 6L and 6R. The conveyor 6L comprises essentially two tractive carrier cables, 60aL and 60bL, driven to travel on themselves respectively along parallel paths that are each defined by a plurality of guide wheels 63aL, or 63bL respectively. The conveyor 6R comprises essentially, in symmetrical manner, two tractive carrier cables 60aR, 60bR, tensioned on a path defined for each by a plurality of guide wheels 63aR, 63bR. The cables 60aL and 60bL thus describe respectively

two loops facing one another along the conveyor circuit of the left conveyor and the cables 60aR and 60bR describe respectively two loops opposite one another along the closed loop circuit of the right conveyor. The two circuits, hence the four closed loop paths, are situated in parallel vertical planes, and they have identical shapes at each point at the same horizontal level.

The fixed framework supporting the various guide wheels (numbered 63 in figure 6, or 63aL, 63bL, 63aR, 63bR in figure 5) by their respective axles is illustrated in the form of vertical portal frames 64 each comprising essentially two side uprights joined together by a top horizontal beam 64H and supplemented by two intermediate uprights 64'L and 64'R. It is in the space made between each side upright and the intermediate upright opposite, that the cable guide wheels are mounted. The gap left clear between two wheels facing one another, relating respectively to the two cables of one same conveyor, is sufficient for a pendle arm driven by the two coupled cables to pass freely hanging between them, without impact or friction. This gap is in practice chosen to be sufficient to also accept the lateral clearances that may be allowed by the natural flexibility of the tensioned cables when the installation is in operation.

The backward path of the pendle arms 4 is represented partially in figure 6 for the pendle arms of the right conveyor of figure 5. This shows that the arms 4 return towards the loading end in a position tilted horizontally, and therefore turned upward. A guide rail 40 is installed in order to bring the arms to this position and keep them there when they move empty in the inactive portion of the transport loops, along the backward stretch situated, as shown, in the upper portion, above the forward stretch, in the same vertical plane. Note also that it may be advantageous to shorten the circuit in its portion for returning the arms empty, by providing therein a substantially rectilinear horizontal path to return from the unloading station to the loading station, even in the case of a forward path with incline slopes such as that in figure 2. Furthermore, the guide wheels may be substantially further apart therein, without fearing that the

tension forces of the cables are insufficient to prevent them flexing which could be awkward.

Figure 6 also illustrates a variant embodiment of the installation according to the invention in which the return wheel causing a cable of the forward path to pass to the backward path is in fact made up of a set of several wheels 62, guiding the cable to bend through 180 degrees at the end of the installation where the loading station is situated. Thus using several smaller wheels rather than a single wheel tends to distribute the forces and reduce the space requirement and costs, in addition to facilitating less tight bends.

Note finally, incidentally, that in figure 3 the hooks 42 were open forward, whereas in figure 6 they are open rearward, so that they engage with the handles 30 of the sleds by placing themselves in front thereof.

Figures 10 and 11 show more precisely, for one of the two conveyors of the installation according to the preferred embodiment of the dual-cable conveyors, the mechanical relationships existing between the wheels 63a and 63b of a pair of guide wheels, the corresponding coupled cables 60a and 60b and a pendle arm 4, represented at the moment when it passes between the guide wheels. The guide wheels of the cables have sheave grooves receiving the corresponding tensioned cable to prevent it from straying sideways from its path, without for all that restraining its longitudinal movement on itself. They are mounted to rotate freely on themselves, about their respective axles, on fixed beams of the installation, 65a and 65b. As has already been indicated, a sufficient spacing is provided between the wheels 63a and 63b facing one another to allow the pendle arms 4 to pass freely hanging between them.

Furthermore, figures 10 and 11, like figures 8 and 9, show a roller 41, which is provided at the end of each pendle arm, on the hook 42. It is placed to roll on the rail 40 of figure 6 in order to keep the arm 4 in the tilted position.

As for the system providing the pivoting assembly of the arms on the cables and the coupling of the two cables of one single conveyor, it appears in greater detail in figure 12, which shows an arm 4 hanging between two wheels 63a and 63b, free to rotate on the elements of fixed framework 64. At its top end, the arm 4 terminates with an articulation piece illustrated by a race 43, in which a pin 46 swivels and which is held laterally by mounting collars 48. The race 43 forms a rolling bearing cage of horizontal axis perpendicular to the line of transport and centered in the plane of the coupled cables. On either side of the race 43, the rotary pin 46 extends into two opposite legs, 47a and 47b respectively. At the end of each of them there is the grip clamped onto the corresponding cable. Each grip 45a or 45b is, in practice, formed of two jaws 68 and 69, one above the other, which are clamped tight against the cable, on one side on the leg extending the race 46 of the articulated mount, and on the other side on a thickness spacer 49. In manufacturing practice, each spacer may be cast in a single piece with one of the jaws of the corresponding grip.

Finally, figure 7 also refers to a particular embodiment of the invention, in an installation version with two dual-cable conveyors, to illustrate the means of tensioning the cables prior to assembling the pendle arms that were dealt with at the beginning of the present description. This figure shows that each of the conveyors 6L and 6R is associated with a plate 82 which is mounted mobile in longitudinal translation on two side rails of the fixed framework 64. Each plate 82 carries with it two side plates which have not been shown so as to reveal that they support between them the mobile members associated respectively with the two cables of the corresponding conveyor. Such is the matter, on either side of each conveyor, for the rotation axle of the driving motive wheel 61 driving a cable situated on this side, and for the associated control and transmission motorized assembly 83. The cables 60 having been closed on their respective loop circuits, by running around the return wheels 61, the plates 82 are progressively moved, to lengthen the circuits, by means of motorized cylinders 84, which press on a crossmember 86 of the fixed framework to push via a telescopic rod and a crossbar 85 on the

corresponding plate 82. When the lengthening operation is completed, the assembly grips of the pendles for suspending the loads are put in place. Advantageously, the cylinders remain under pressure during the operation of the installation and the plates 82 remain mobile. They are guided in their movements by forks furnished with rollers 89 which straddle a metal strip 87 of the fixed framework forming a slide.

As has already been indicated, figure 2 illustrates the invention in a particular embodiment of the conveyor circuits in which each car body conveyed must not only be dipped in a tank 2, but also be subjected therein to an electrolytic treatment. In practice, the tank 2 containing an electrolyte bath 20 is connected by electrodes 35 to the positive terminal 32 of a source of current 9, whose negative terminal 31 is taken to the electrical ground T. Every car body 5 dipped in the tank is connected to the ground potential T via an electric connection which is made pass through the suspension arms 4. The latter are produced for this purpose of metal materials having a good electric conductibility to ground. A good electric contact is also provided to the car body itself, passing through the sled 3.

At the handles 30 engaged with the hooks 42 of the arms 4, the necessary electrical contact is greatly facilitated both by the fact that the suspension of the sleds is of the type with four independent arms, and by the fact that the tractive means consist of tensioned cables supporting the weight of the car bodies being treated.

Contact with the electrical earth is provided, at the top end of the arms 4, on a section of the conveyor circuit which runs along the tank 2, in order that every portion of the car body 5 immersed in the liquid is connected to ground potential. The ground circuit organized for this purpose, according to figure 2, comprises an electric rail 33 running parallel to the circuit of the cable on its forward path, and each arm 4 is fitted at its top end with a sprung pantograph or similar device elastically pushing on a skid 34 in order to keep it in electrical sliding contact with the rail 33. This device may be supplemented by an electric linking braid between the skid and the

arm 4 itself. On the other hand, the guide wheels of the cables are electrically insulated to prevent current leakage to the framework elements which are usually metal.

In accordance with a particular feature of the invention applying here advantageously, although non limitingly, use is made of the possibility of the cables to act as electric conductors in order to dispense with certain of the skid devices 41. More precisely, such skids are provided for one arm 4 in every two along a cable 60. Preferably it will involve thus equipping the arm 4 that is the first to be attached to a sled 3. This then ensures a good electric contact between each arm and the corresponding carrier cable, at the articulated assembly device. The same quality of electric contact is ensured, not only for the arm attached at the front of the sled, which is connected directly to the electric ground by a skid device 34, but also for the arm placed at the rear. Between the two the electricity is conducted by the cable, made a conductor for this purpose, such that the ground circuit includes the cable 60 for its section situated between the two arms engaged with a single sled, one at the front and the other at the rear. The same arrangements are adopted for the electric ground circuit associated with the second conveyor, on the other side of the conveyor line.

Although an effort has been made hereinabove to illustrate several embodiments of an installation according to the invention, the outcome nevertheless is that the invention is not limited thereto and that it extends to the various technically operative combinations of the variants that have been described, and to any variant using equivalent means.